FIG.1
Related Art

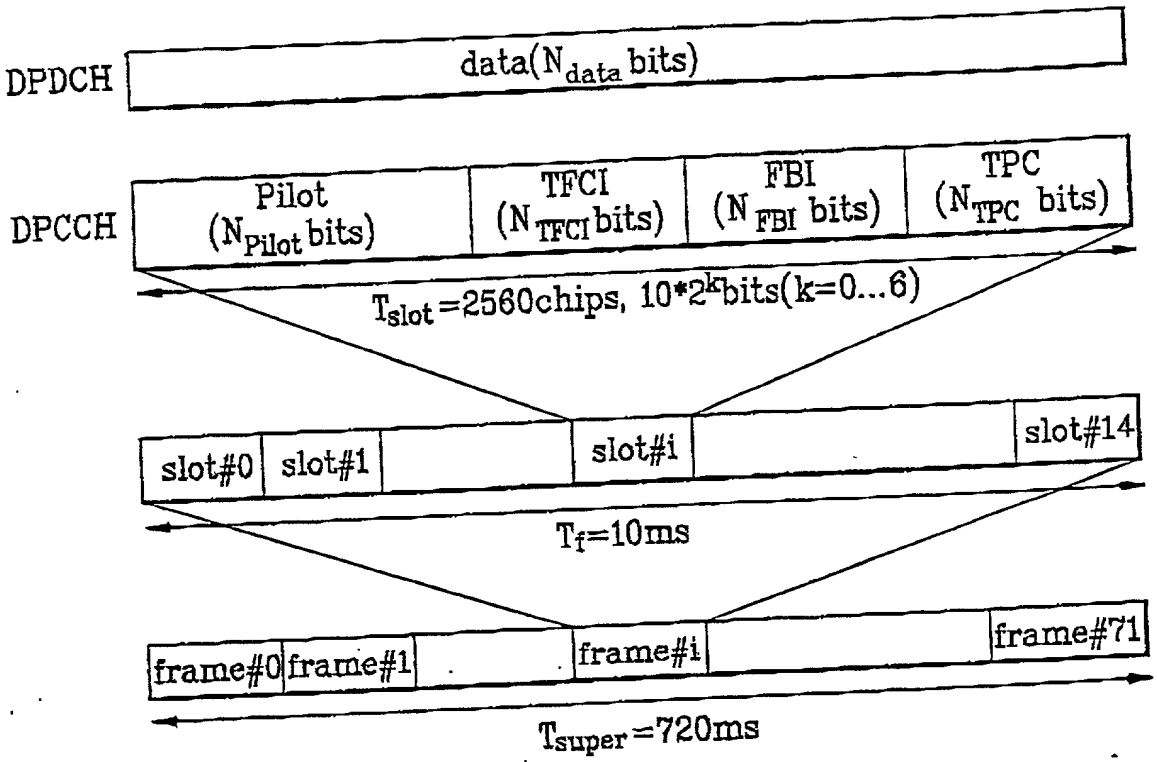

FIG.2
Related Art

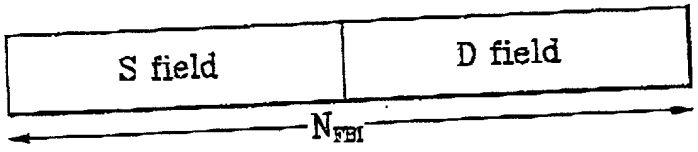

FIG.3a

Hadarmad codes of 8 bits	Hadarmad codes of 16 bits
$H_{3,0}$ =0000 0000	$H_{4,0}$ =0000 0000 0000 0000
	$H_{4,1}$ =0101 0101 0101 0101
$H_{3,1}$ =0101 0101	$H_{4,2}$ =0011 0011 0011 0011
	$H_{4,3}$ =0110 0110 0110 0110
$H_{3,2}$ =0011 0011	$H_{4,4}$ =0000 1111 0000 1111
	$H_{4,5}$ =0101 1010 0101 1010
$H_{3,3}$ =0110 0110	$H_{4,6}$ =0011 1100 0011 1100
	$H_{4,7}$ =0110 1001 0110 1001
$H_{3,4}$ =0000 1111	$H_{4,8}$ =0000 0000 1111 1111
	$H_{4,9}$ =0101 0101 1010 1010
$H_{3,5}$ =0101 0101	$H_{4,10}$=0011 0011 1100 1100
	$H_{4,11}$=0110 0110 1001 1001
$H_{3,6}$ =0011 1100	$H_{4,12}$=0000 1111 1111 0000
	$H_{4,13}$=0101 1010 1010 0101
$H_{3,7}$ =0110 1001	$H_{4,14}$=0011 1100 1100 0011
	$H_{4,15}$=0110 1001 1001 0110

FIG.3b

bi-orthogonal codes of 8 bits	bi-orthogonal codes of 16 bits
$B_{3,0}$ =0000 0000	$B_{4,0}$ =0000 0000 0000 0000
$B_{3,1}$ =1111 1111	$B_{4,1}$ =1111 1111 1111 1111
$B_{3,2}$ =0101 0101	$B_{4,2}$ =0101 0101 0101 0101
$B_{3,3}$ =1010 1010	$B_{4,3}$ =1010 1010 1010 1010
$B_{3,4}$ =0011 0011	$B_{4,4}$ =0011 0011 0011 0011
$B_{3,5}$ =1100 1100	$B_{4,5}$ =1100 1100 1100 1100
$B_{3,6}$ =0110 0110	$B_{4,6}$ =0110 0110 0110 0110
$B_{3,7}$ =1001 1001	$B_{4,7}$ =1001 1001 1001 1001
$B_{3,8}$ =0000 1111	$B_{4,8}$ =0000 1111 0000 1111
$B_{3,9}$ =1111 0000	$B_{4,9}$ =1111 0000 1111 0000
$B_{3,10}$=0101 1010	$B_{4,10}$=0101 1010 0101 1010
$B_{3,11}$=1010 0101	$B_{4,11}$ =1010 0101 1010 0101
$B_{3,12}$=0011 1100	$B_{4,12}$=0011 1100 0011 1100
$B_{3,13}$=1100 0011	$B_{4,13}$=1100 0011 1100 0011
$B_{3,14}$=0110 1001	$B_{4,14}$=0110 1001 0110 1001
$B_{3,15}$=1001 0110	$B_{4,15}$=1001 0110 1001 0110
	$B_{4,16}$=0000 0000 1111 1111
	$B_{4,17}$=1111 1111 0000 0000
	$B_{4,18}$=0101 0101 1010 1010
	$B_{4,19}$=1010 1010 0101 0101
	$B_{4,20}$=0011 0011 1100 1100
	$B_{4,21}$=1100 1100 0011 0011
	$B_{4,22}$=0110 0110 1001 1001
	$B_{4,23}$=1001 1001 0110 0110
	$B_{4,24}$=0000 1111 1111 0000
	$B_{4,25}$=1111 0000 0000 1111
	$B_{4,26}$=0101 1010 1010 0101
	$B_{4,27}$=1010 0101 0101 1010
	$B_{4,28}$=0011 1100 1100 0011
	$B_{4,29}$=1100 0011 0011 1100
	$B_{4,30}$=0110 1001 1001 0110
	$B_{4,31}$=1001 0110 0110 1001

FIG. 4A

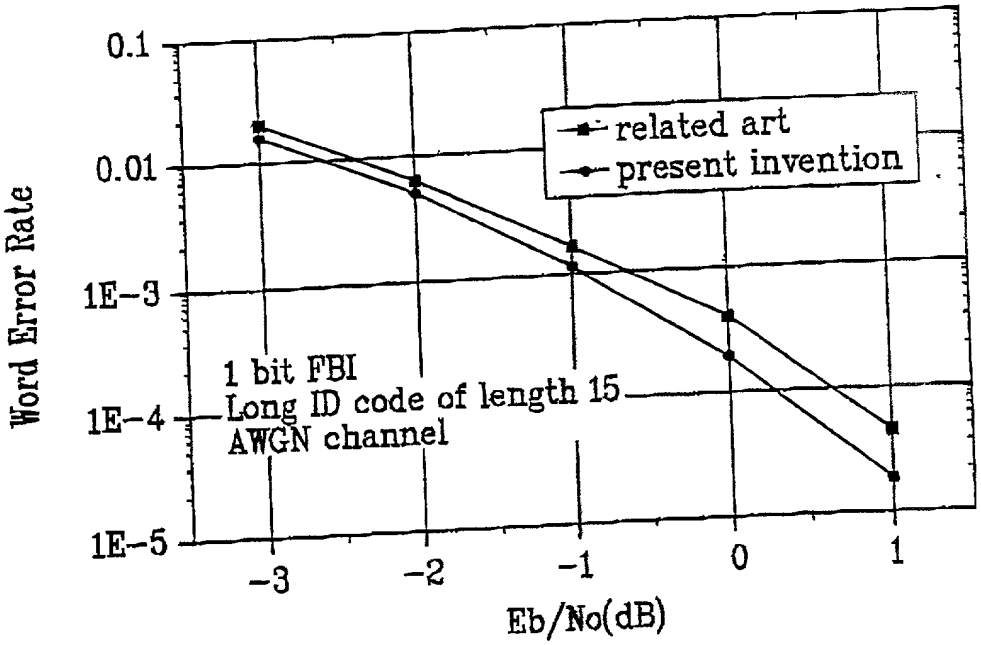
0.1
0.01
1E-3
1E-4
1E-5
Word Error Rate
related art
present invention
1 bit FBI
Long ID code of length 15
AWGN channel
-3
-2
-1
0
1
Eb/No(dB)

FIG. 4B

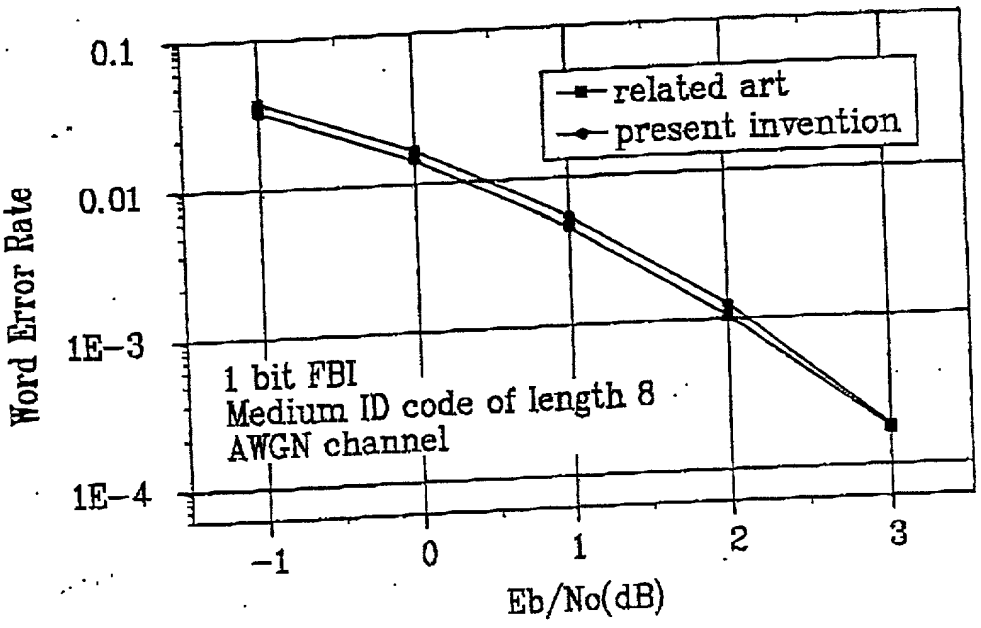
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
1 bit FBI
Medium ID code of length 8
AWGN channel
-1
0
1
2
3
Eb/No(dB)

FIG. 4C

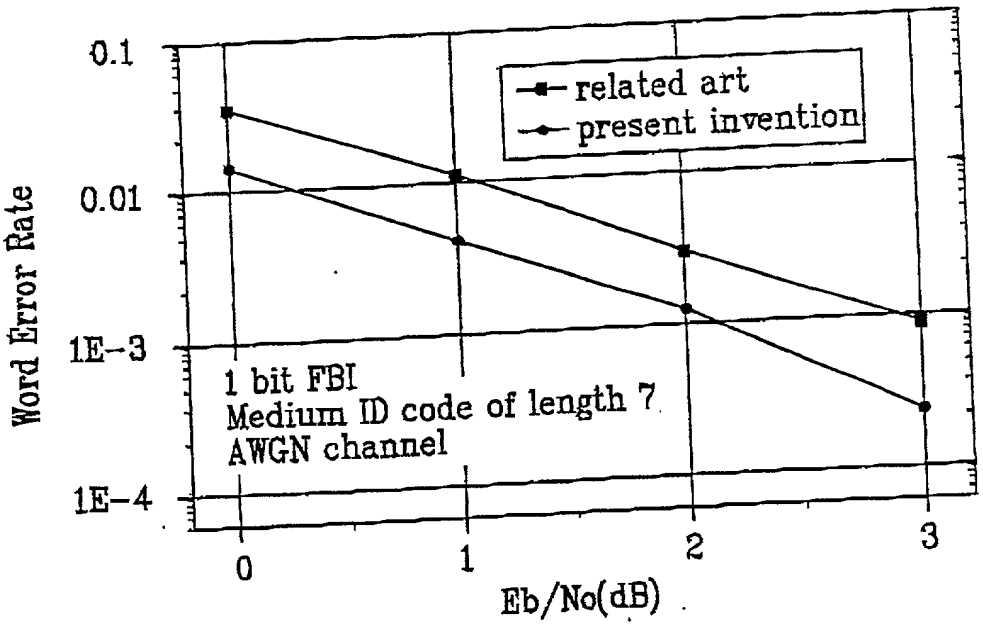
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
1 bit FBI
Medium ID code of length 7
AWGN channel
0
1
2
3
Eb/No(dB)

FIG. 4D

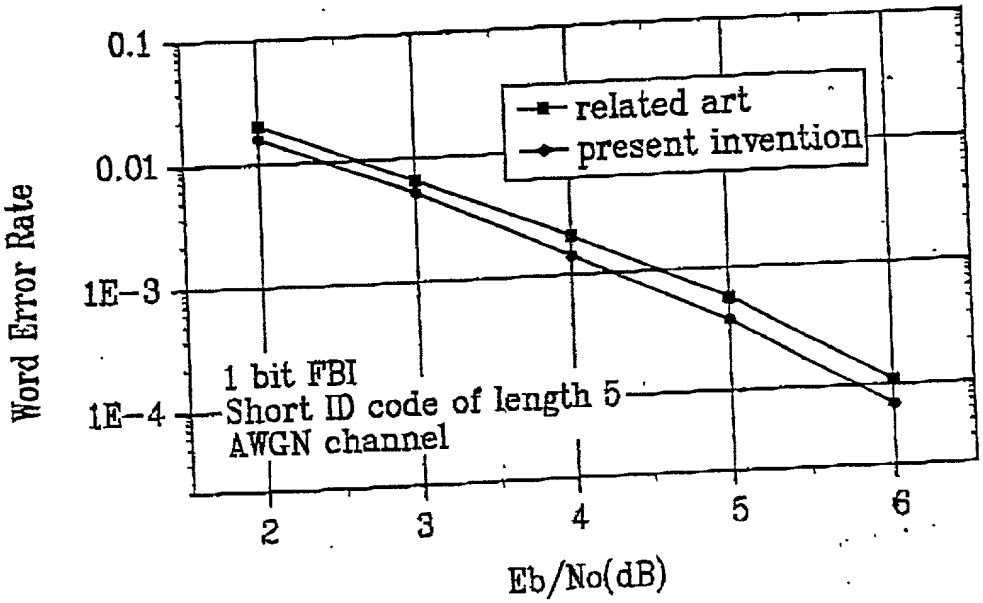
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
1 bit FBI
Short ID code of length 5
AWGN channel
2
3
4
5
6
Eb/No(dB)

FIG.5A

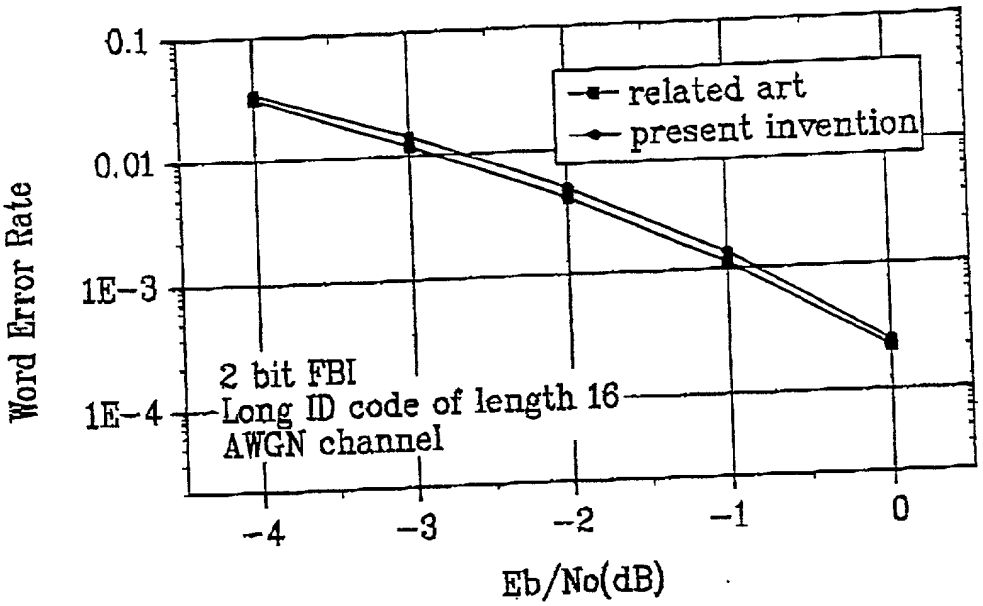
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
2 bit FBI
Long ID code of length 16
AWGN channel
-4
-3
-2
-1
0
Eb/No(dB)

FIG.5B

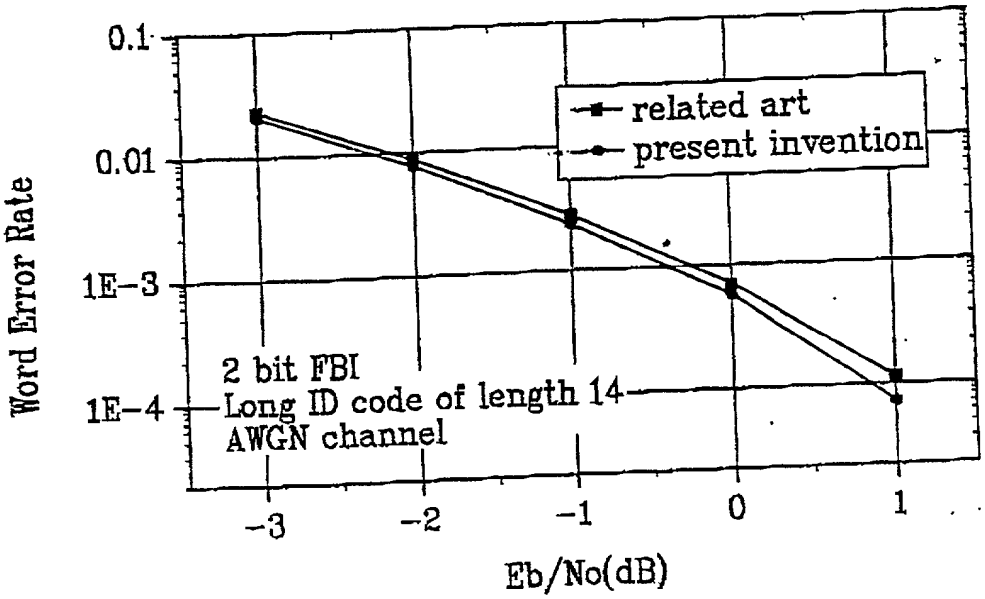
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
2 bit FBI
Long ID code of length 14
AWGN channel
-3
-2
-1
0
1
Eb/No(dB)

FIG.5C

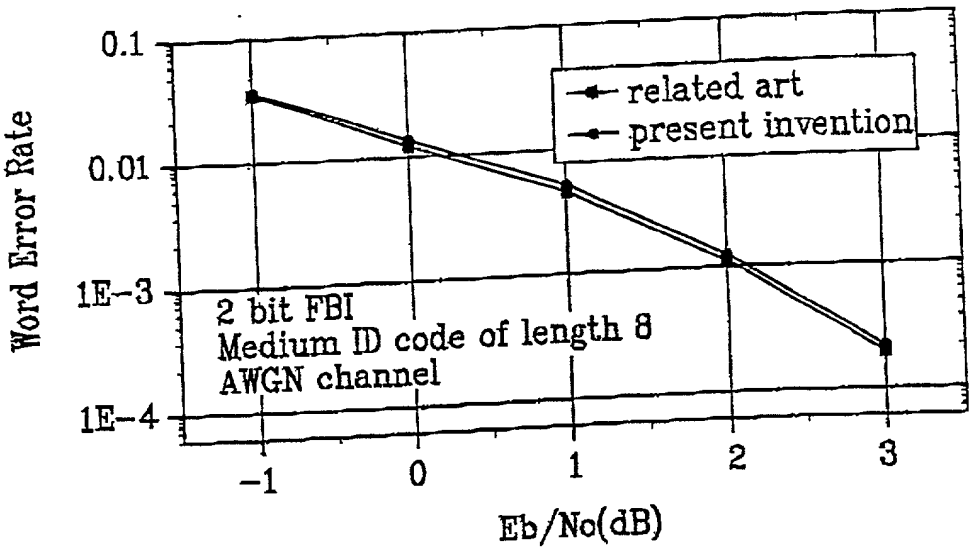
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
2 bit FBI
Medium ID code of length 8
AWGN channel
-1
0
1
2
3
Eb/No(dB)

FIG.5D

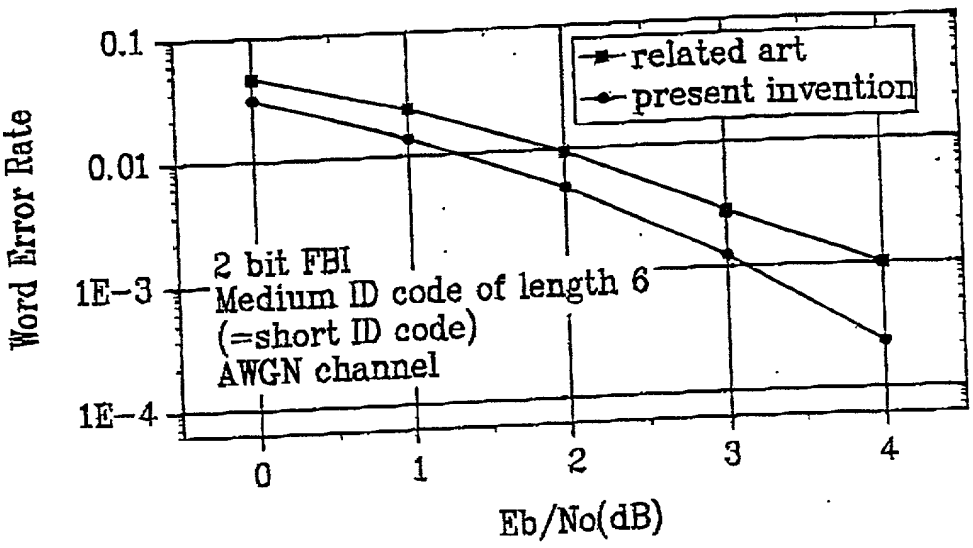
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
2 bit FBI
Medium ID code of length 6
(=short ID code)
AWGN channel
0
1
2
3
4
Eb/No(dB)

FIG.6A

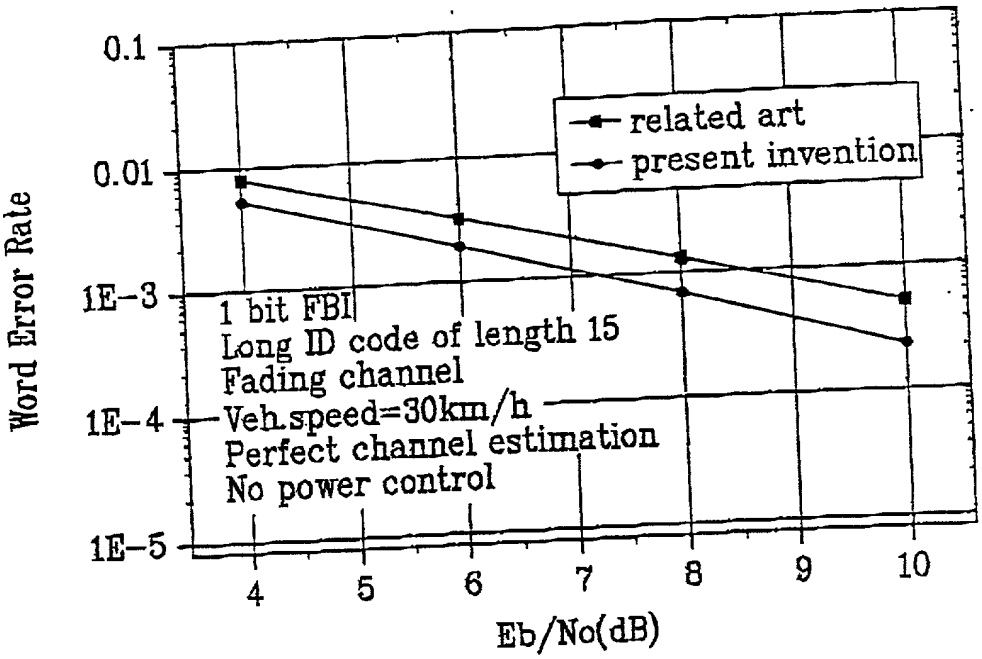
0.1
0.01
1E-3
1E-4
1E-5
Word Error Rate
related art
present invention
1 bit FBI
Long ID code of length 15
Fading channel
Veh.speed=30km/h
Perfect channel estimation
No power control
4
5
6
7
8
9
10
Eb/No(dB)

FIG.6B

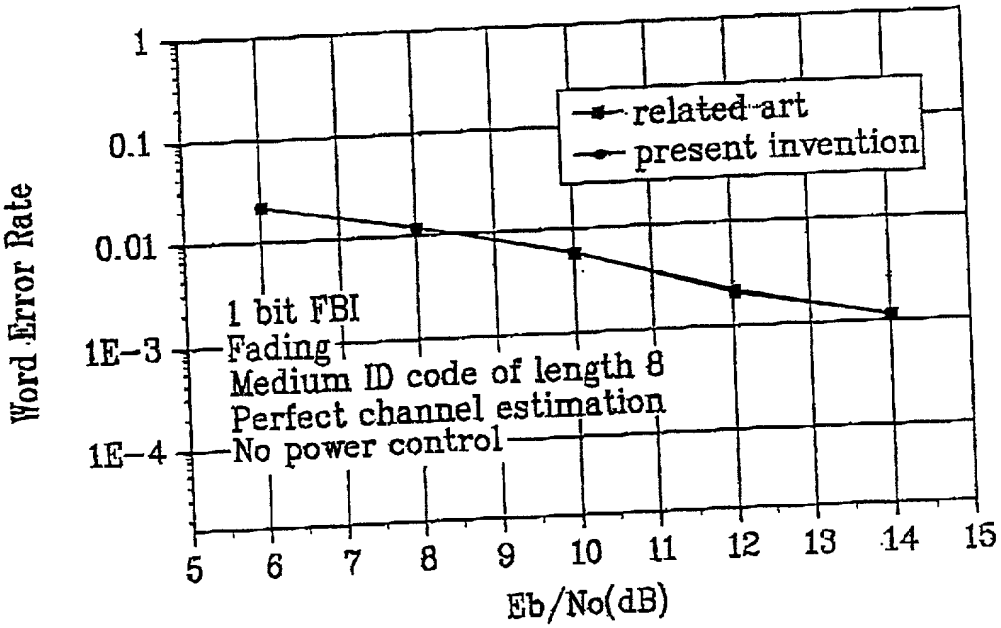
1
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
1 bit FBI
Fading
Medium ID code of length 8
Perfect channel estimation
No power control
5
6
7
8
9
10
11
12
13
14
15
Eb/No(dB)

FIG.6C

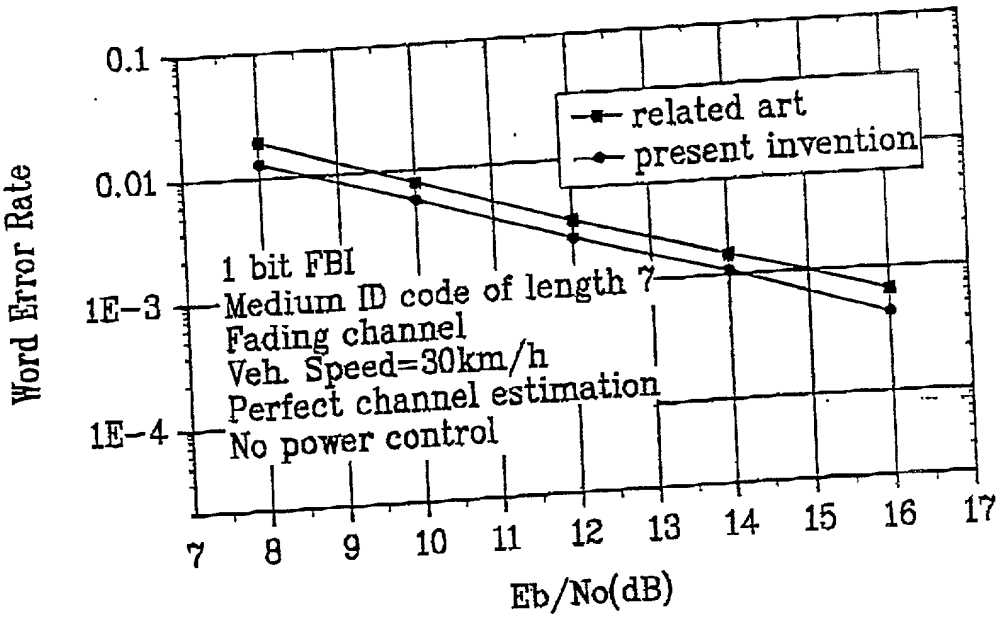
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
1 bit FBI
Medium ID code of length 7
Fading channel
Veh. Speed=30km/h
Perfect channel estimation
No power control
7
8
9
10
11
12
13
14
15
16
17
Eb/No(dB)

FIG.6D

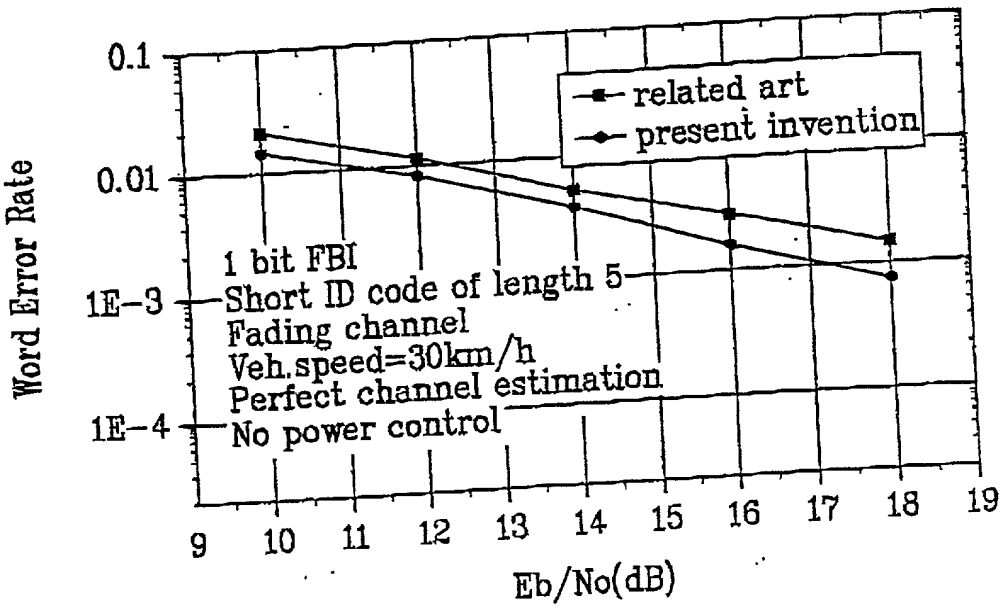
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
1 bit FBI
Short ID code of length 5
Fading channel
Veh.speed=30km/h
Perfect channel estimation
No power control
9
10
11
12
13
14
15
16
17
18
19
Eb/No(dB)

FIG.7A

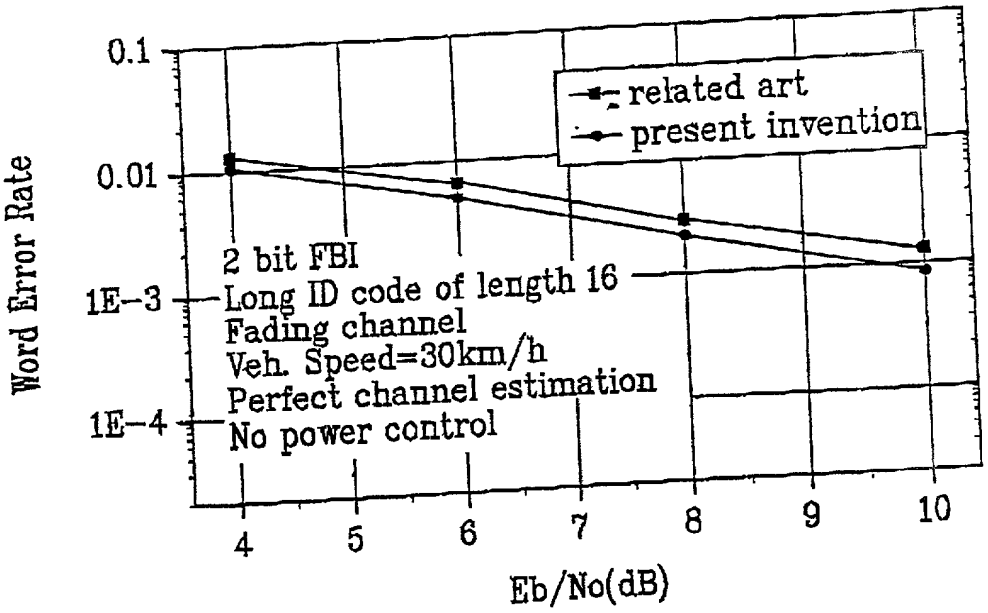
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
2 bit FBI
Long ID code of length 16
Fading channel
Veh. Speed=30km/h
Perfect channel estimation
No power control
4
5
6
7
8
9
10
Eb/No(dB)

FIG.7B

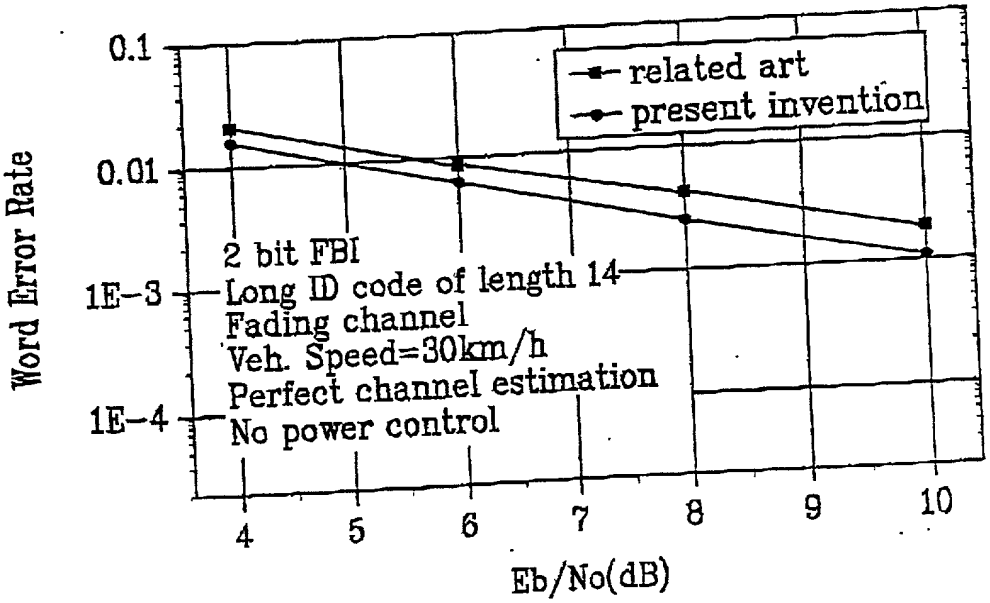
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
2 bit FBI
Long ID code of length 14
Fading channel
Veh. Speed=30km/h
Perfect channel estimation
No power control
4
5
6
7
8
9
10
Eb/No(dB)

FIG.7C

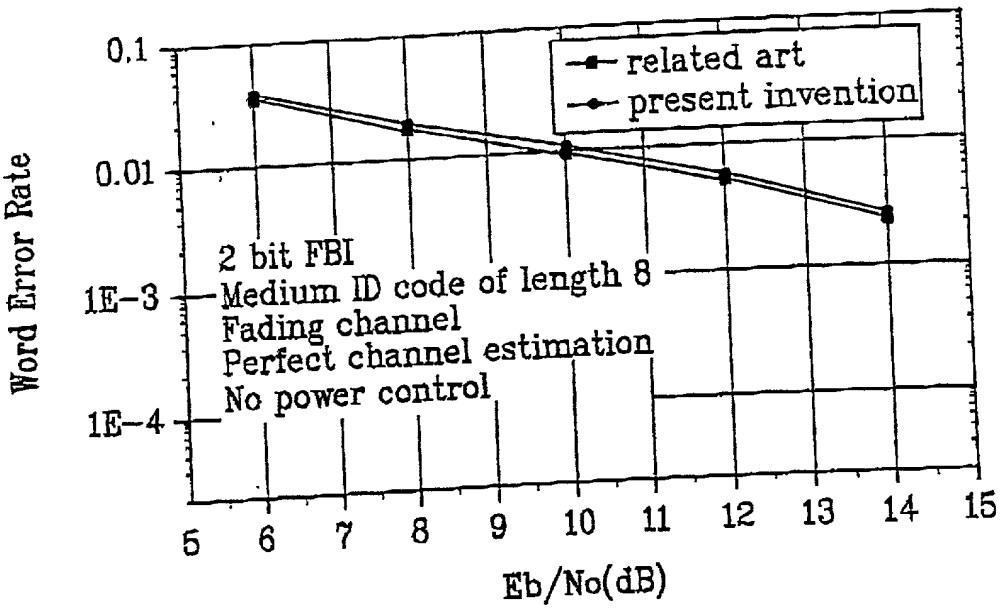
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
2 bit FBI
Medium ID code of length 8
Fading channel
Perfect channel estimation
No power control
5
6
7
8
9
10
11
12
13
14
15
Eb/No(dB)

FIG.7D

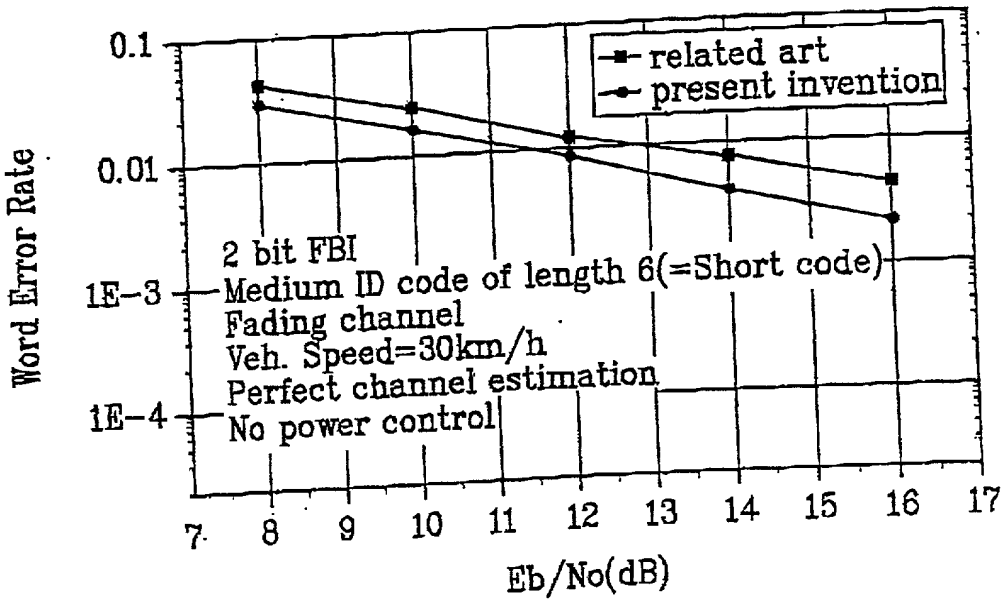
0.1
0.01
1E-3
1E-4
Word Error Rate
related art
present invention
2 bit FBI
Medium ID code of length 6(=Short code)
Fading channel
Veh. Speed=30km/h
Perfect channel estimation
No power control
7
8
9
10
11
12
13
14
15
16
17
Eb/No(dB)

FIG.8A

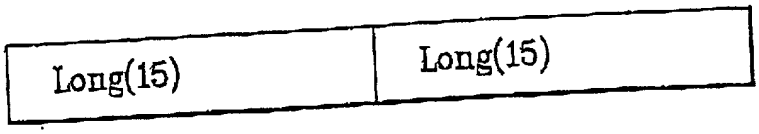

FIG.8B

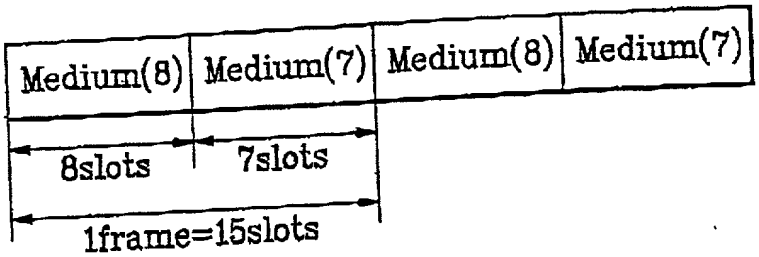

FIG.8C

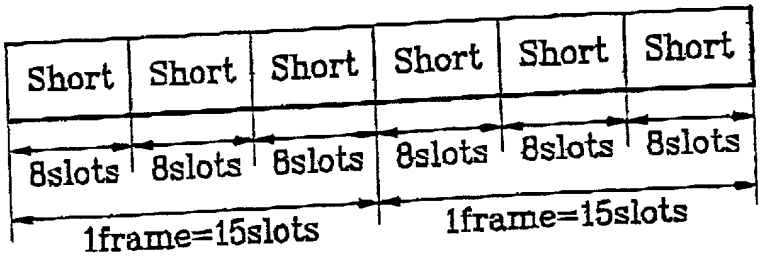

FIG.9A

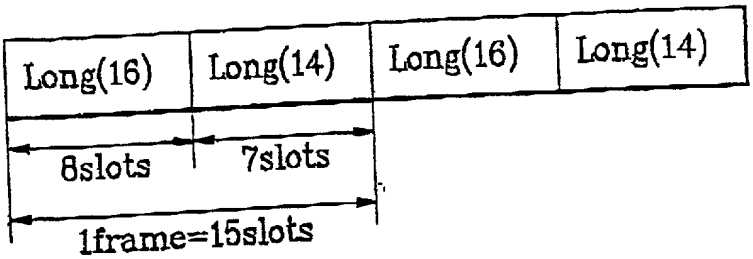

FIG.9B

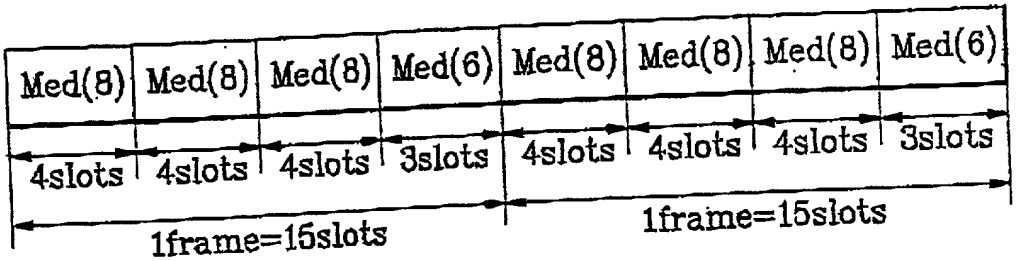

FIG.9C

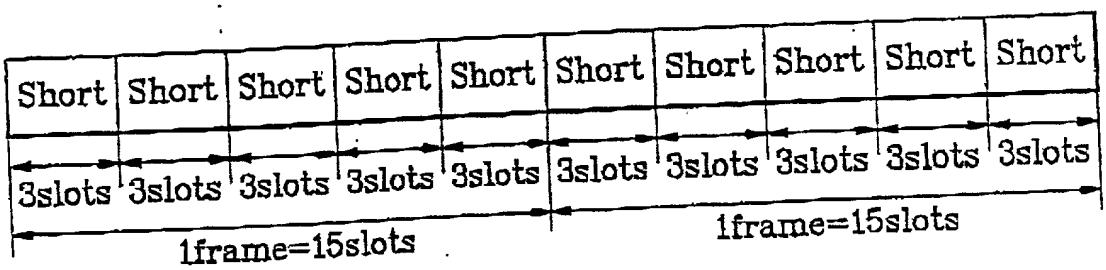

FIG.10A

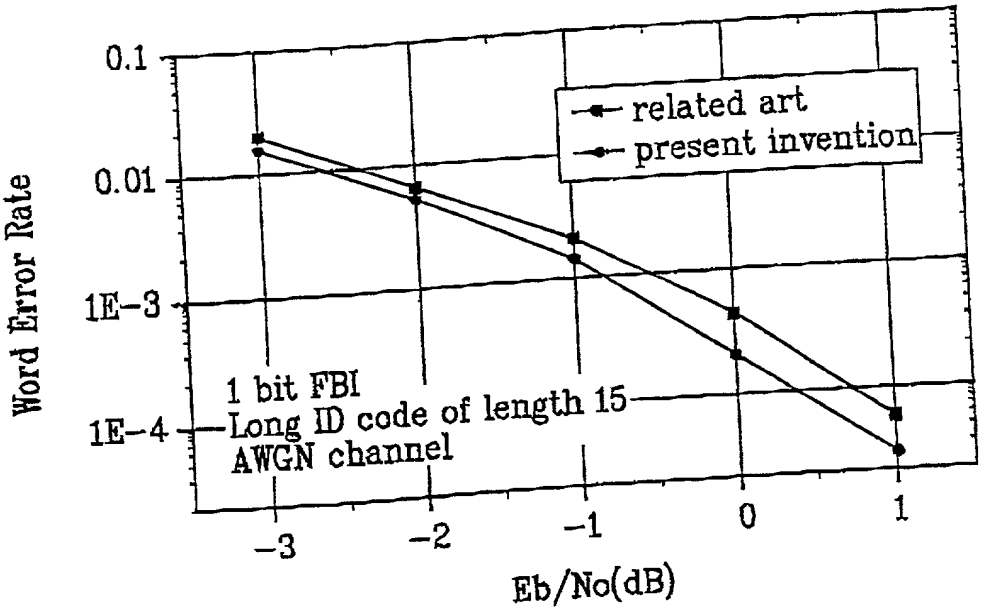

FIG.10B

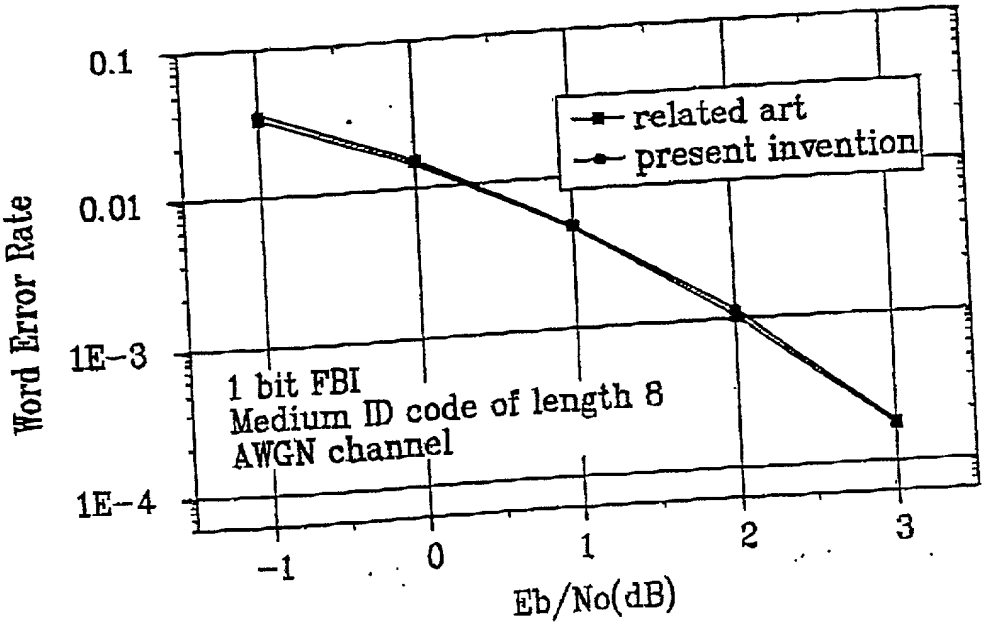

FIG.10C

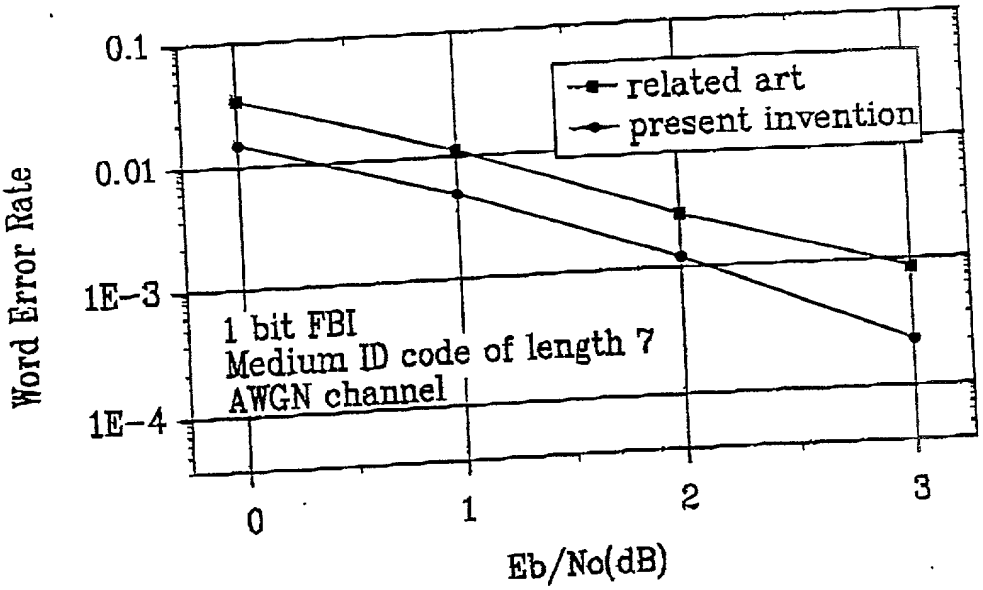

FIG.10D

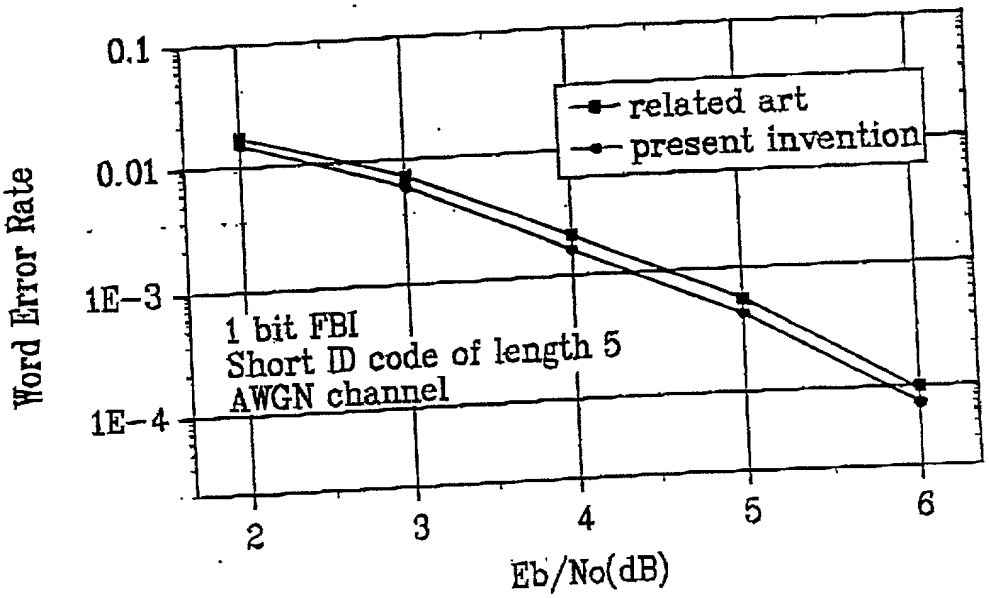

FIG.11A

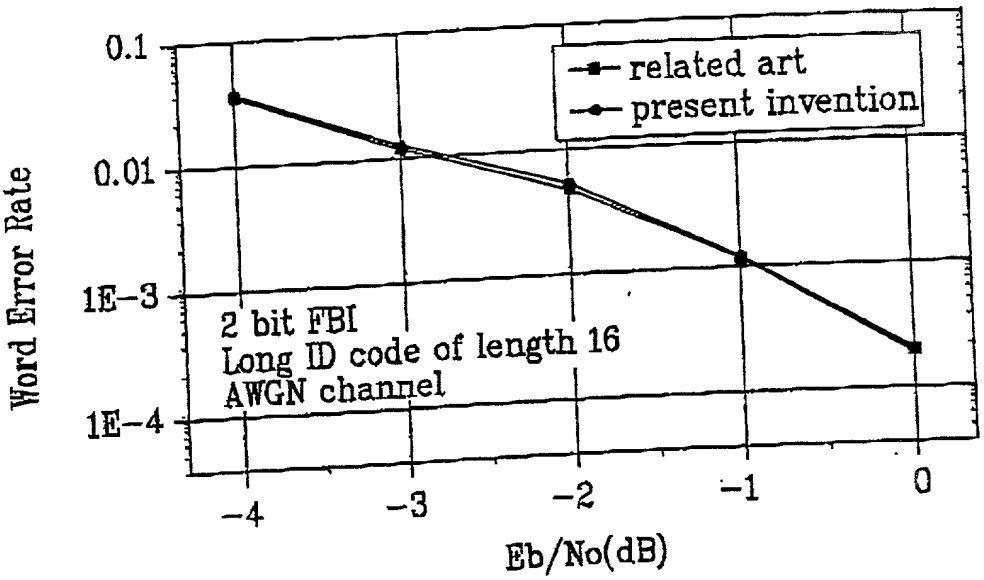

FIG.11B

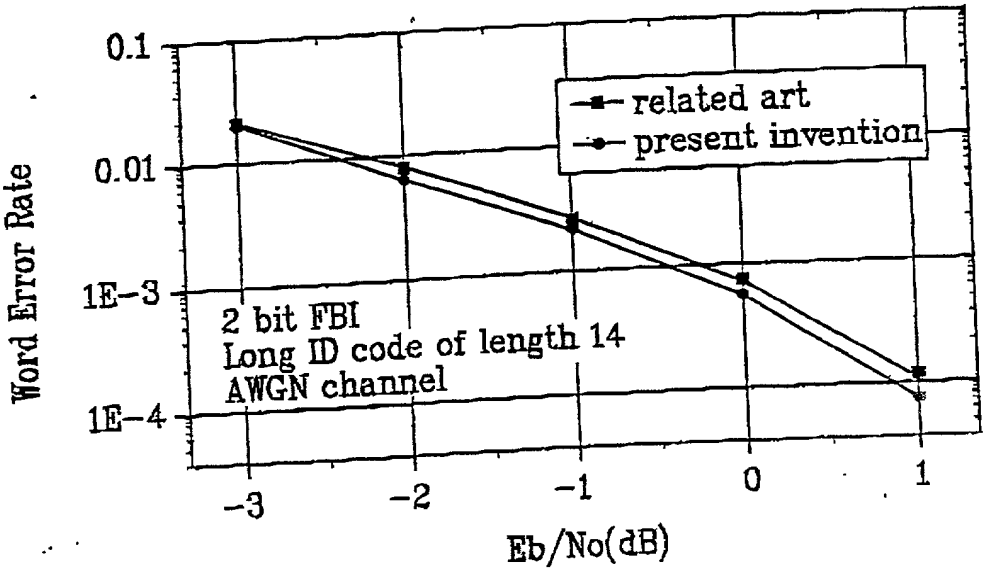

FIG.11C

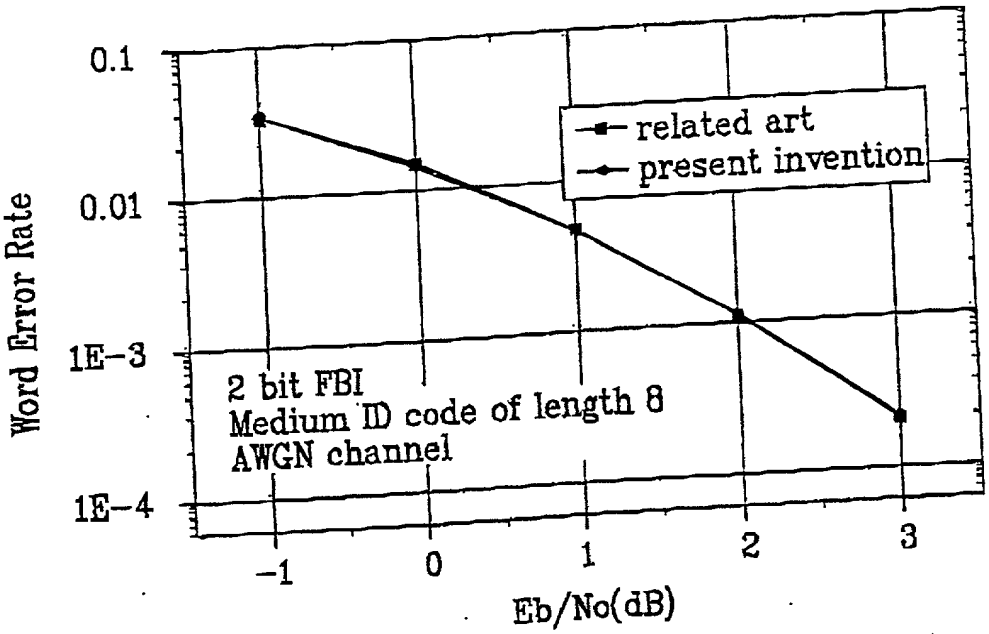

FIG.11D

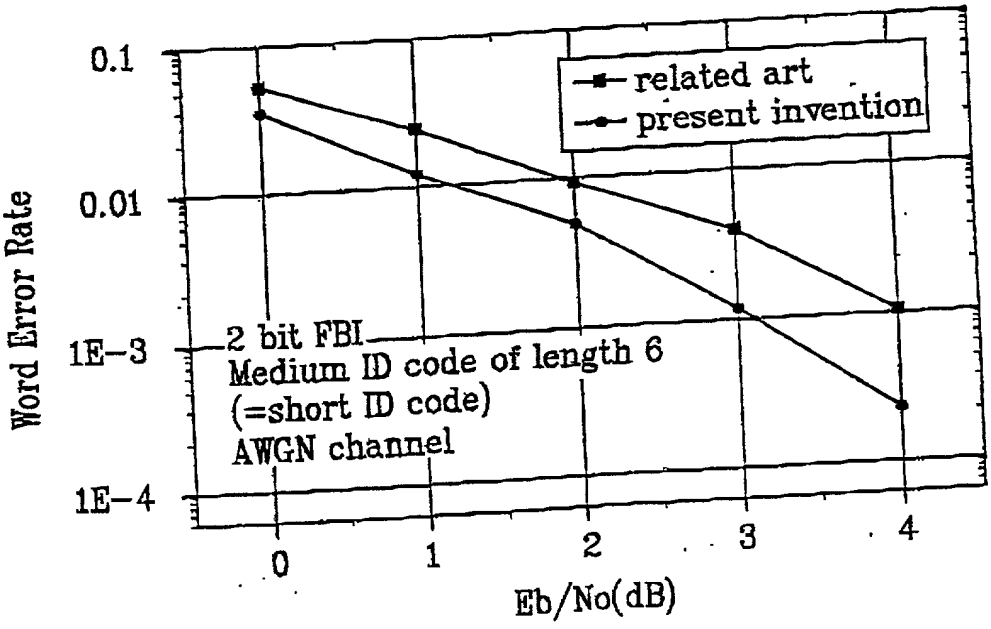

FIG.12A

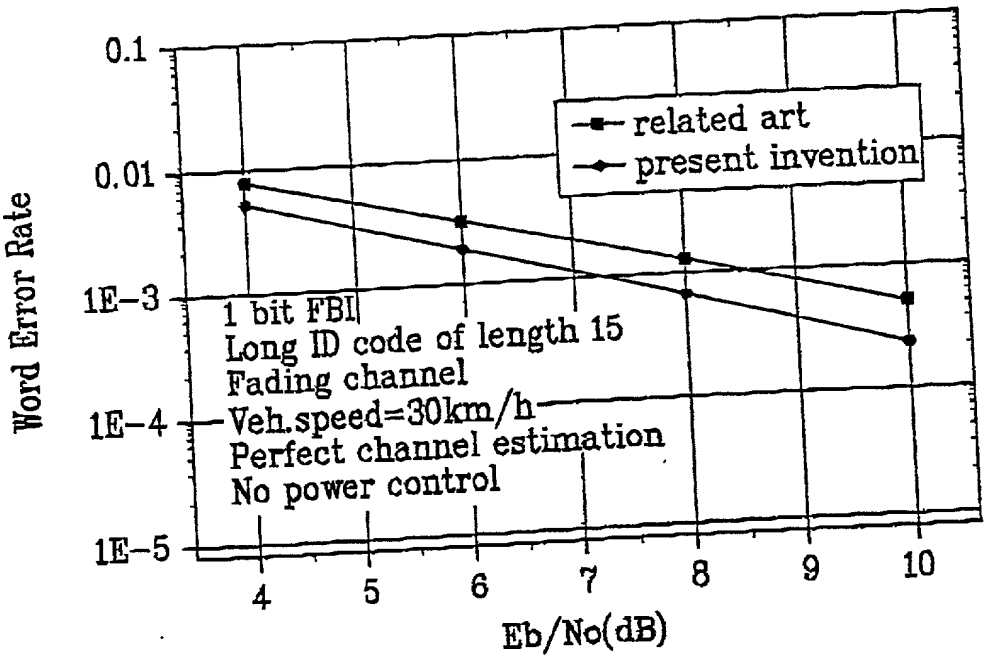

FIG.12B

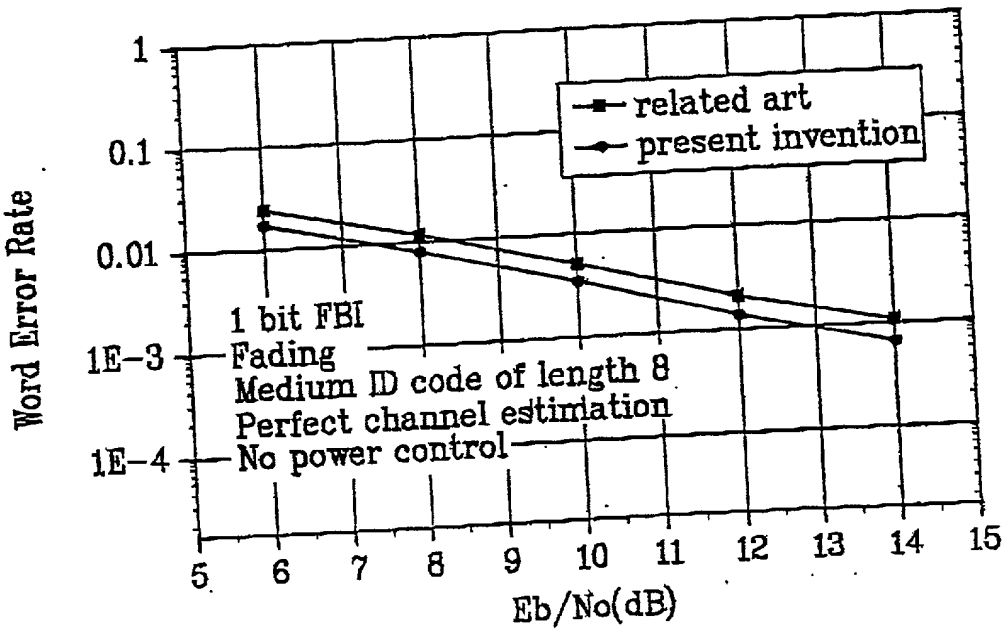

FIG.12C

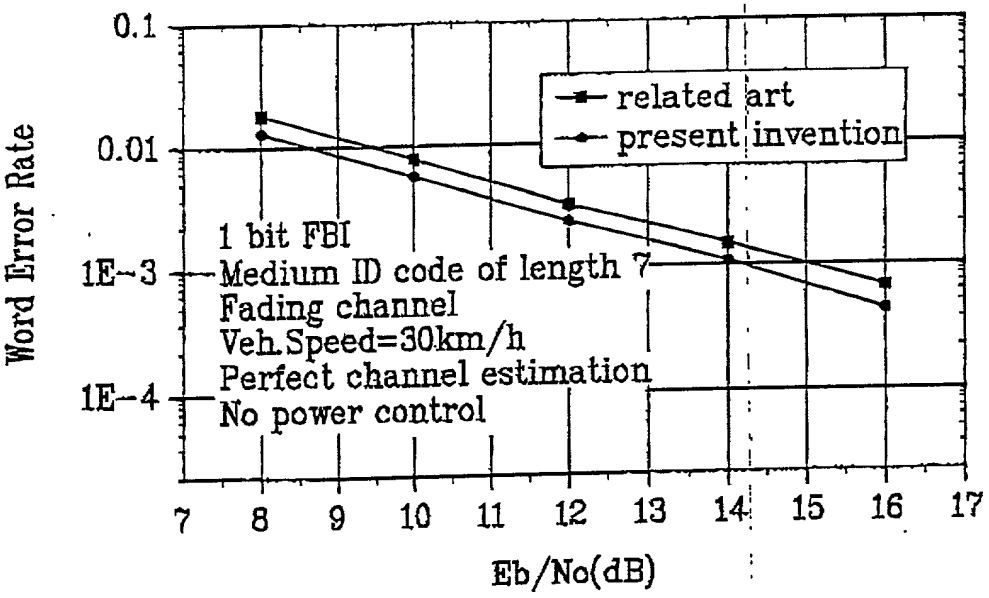

FIG.12D

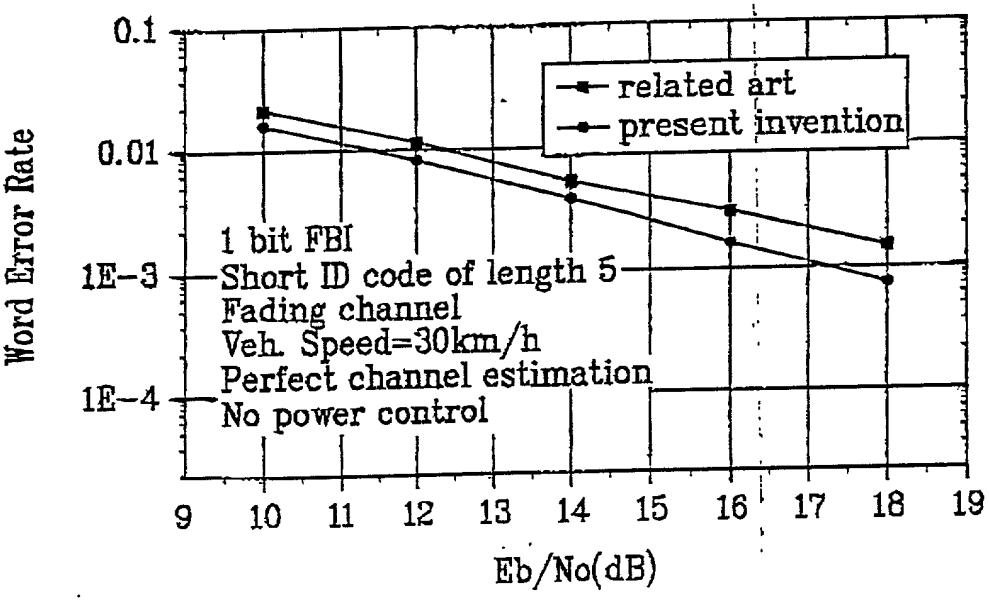

FIG.13A

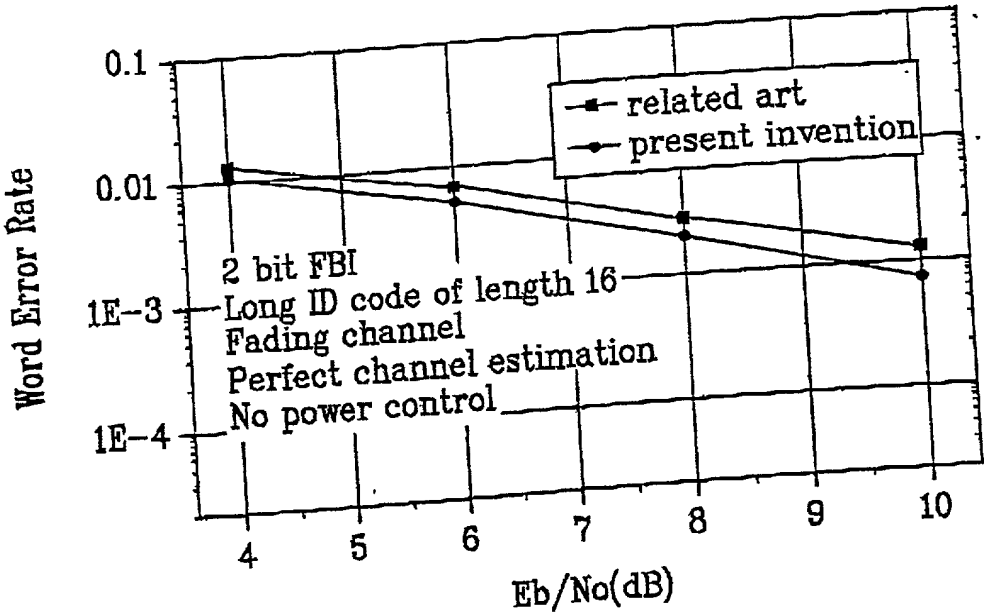

FIG.13B

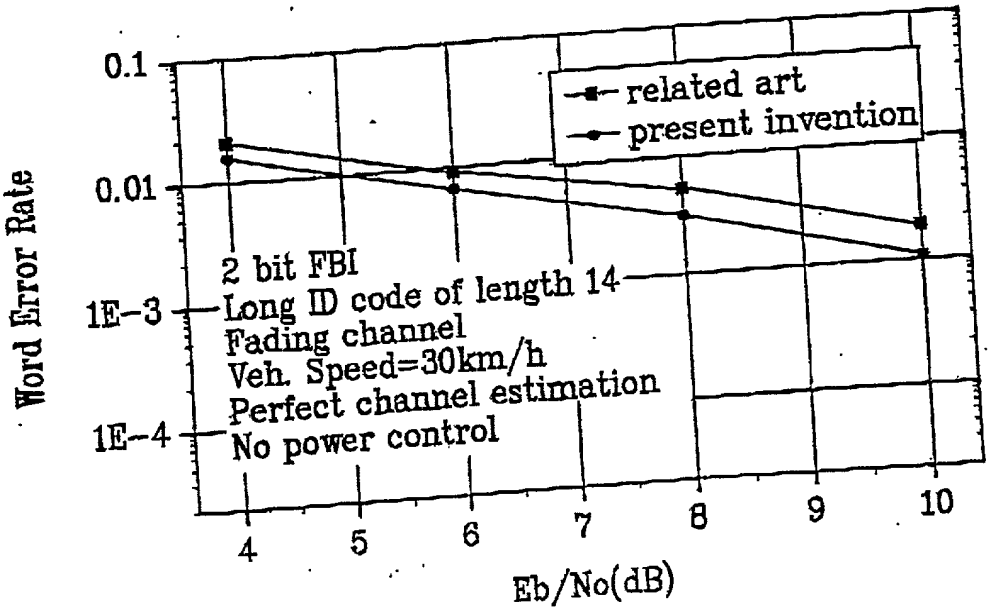

FIG.13C

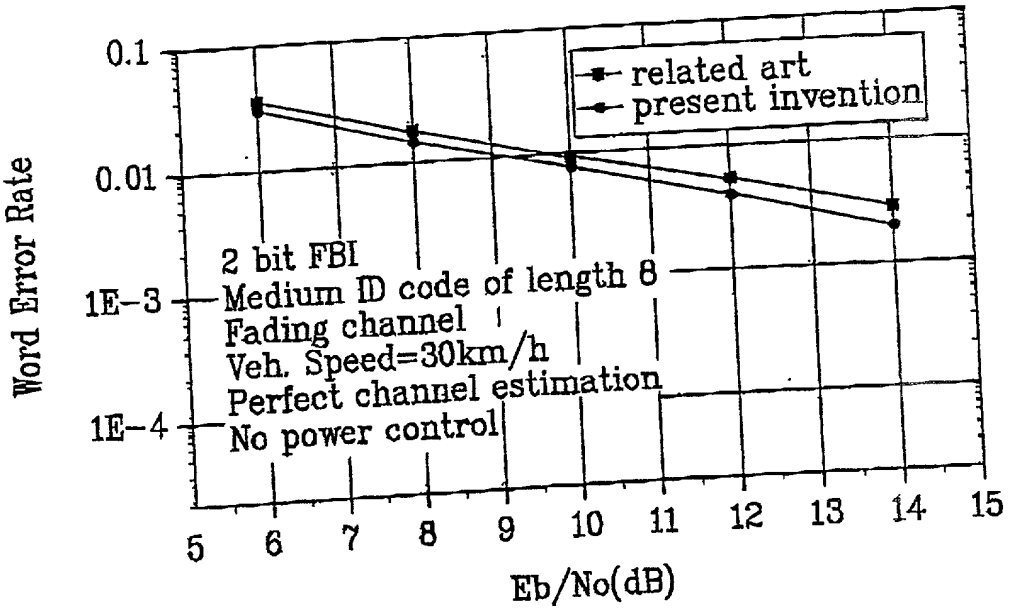
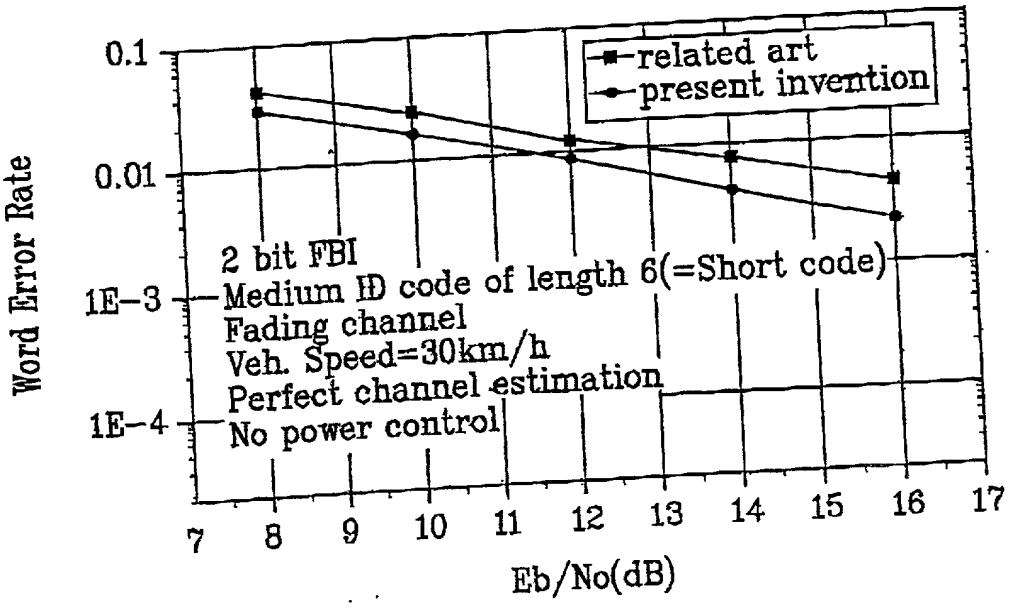
FIG.13D